

Land, Water, and Air



Purpose

To help students understand that land and water heat and cool at different rates and that the properties of soil and water influence the heating of air above them

Overview

Students measure temperature changes in soil, water, and air as they are exposed to the heating action of the sun.

Time

Three to four hours total
one to two hours of actual time on task

Level

Intermediate and advanced

Key Concepts

Different substances, such as soil, water, and air, transfer energy and heat at different rates

Skills

Designing and conducting an experiment
Measuring and recording data
Organizing data in tables
Graphing
Working effectively in groups

Materials and Tools

(per group of students)

Two plastic buckets at least 30 cm tall
A centimeter ruler
Six thermometers
A means to suspend the thermometers over the buckets, such as string and dowels

Preparation

Arrange for an outdoor area in which to conduct the experiment. (This activity could be performed indoors by substituting a strong artificial light source for the sunlight.) This experiment gives the best results on a sunny, warm day. Divide the students into small working groups. You may want to demonstrate the activity first so that all students understand how to conduct the experiment.

Prerequisites

None

Background

One of the important reasons why we have different kinds of weather throughout the world is because land and water heat and cool at different rates.

For example, afternoon thunderstorms in Florida are often initiated by the fact that during the day the land heats up faster than the water does. (To understand more about this, students should research what causes sea breezes.) In parts of the world that experience monsoons (wind systems that reverse direction seasonally), the rainy part of the monsoon season is characterized by alternating periods of active (rainy) and non-

active (not-rainy) weather depending on whether the land is dry or wet.

Students may have observed a difference in the heating and cooling rates of land relative to water if they have ever run barefoot across a beach to the water in the middle of a warm, sunny afternoon. They probably remember how hot the land was and how cool and refreshing the water was. If they were at the beach until after sunset and walked barefoot across the beach to the water, they might remember that at this time of day, it is the beach that feels cool, while the water feels warm. Students can study this land/water difference with a simple experiment.

What To Do and How To Do It

Fill one bucket with soil to a depth of approximately 15 centimeters. Fill the other bucket to the same depth with cool water (as from an outdoor faucet). Set both buckets out in the sun. In each bucket suspend a thermometer one cm above, one cm below, and eight cm below the surface. Try to position the thermometers so that the sunlight is not shining directly on the bulb or the glass tube. Allow time for the thermometer temperatures to stabilize. Record the initial thermometer readings.

Read the temperature of each thermometer at two minute intervals for 20 minutes. Then read the temperatures at one, two, and three hours.

Questions for Discussion

Is the temperature of the soil one cm below the surface warmer than it was when students set out the buckets three hours ago? Is the surface temperature of the water warmer now than it was three hours ago? Why?

Which temperature reading is higher at a depth of 8 cm, that of the soil or that of the water? What conclusions can students draw from this experiment?

What your students should have found was that the soil's surface was much warmer at one cm than that of the water at one cm. On the other hand, the water was warmer at a depth of 8 cm after 3 hours than the soil at a depth of 8 cm. The temperatures at one cm above the surface should be higher for the soil than for the water.

Liquid water molecules move much more freely than the molecules that make up soil. Therefore, water can distribute heat throughout a greater volume than can soil. That is why, after three hours in the sun, the water in the bucket was warmer at the 8 cm depth than was the soil. After sunset, the heat absorbed by soil quickly escapes to the atmosphere, and the land cools rapidly. However, although water heats up more slowly than land, once it is heated it takes longer to cool. If students were to repeat the measurements several hours after sunset, they would find that the water temperature at one cm depth was higher than that of the soil at one cm depth.